REMARKS

INTRODUCTION:

Claim 10 is amended for grammatical clarity and is amended to depend from claim 1. No new matter or new issues for consideration are presented, and the amendment simplifies issues for appeal. Approval and entry of the amendment under 37 CFR 1.116 are respectfully requested.

Claims 1-17 and 29-39 are pending and claims 1-17, 38, and 39 are under consideration. Reconsideration is requested.

Rejection of claims 1- 4, 8 - 17, 38, and 39 in view of Chu and JP '431

In the Office Action at pages 3 - 7, the Examiner rejected claims 1-4, 8-17, 38, and 39 under 35 U.S.C. §103 as allegedly obvious in view of Chu (U.S. Patent No. 5,523,179) and Japanese patent publication no. 47-28431 (hereinafter referred to as "JP '431"). The Examiner alleged that Chu discloses battery cells comprising a sulfur-based positive composite electrode wherein the active sulfur is elemental sulfur or sulfur containing discharge products of elemental sulfur and a negative electrode that comprises lithium metal or lithium-metal alloys. The Examiner further alleged that Chu discloses that the battery cell has a separator and an ion-conducting electrolyte. The Examiner acknowledged that Chu does not disclose a specific pore size and does not disclose the pore size recited in claim 3. The Examiner alleged that the JP '431 publication discloses a sodium-sulfur secondary battery with low voltage drop because of contact resistance wherein the battery comprises a cathode activator of a melted sulfur and that sulfur is an electric insulator so that it is necessary to increase conductivity of the sulfur to react electrochemically in the battery. The Examiner alleged that JP '431 discloses that it is essential to use a porous conductor consisting of a material having a degree of porosity with pore diameters of 10 – 1000 μm as a cathode member to increase the conductivity of the cathode. The Examiner took the position that it would have been obvious to make Chu's positive active material including sulfur by having the specific pore size of the JP '431 publication because the JP '431 publication reveals than in a battery system using sulfur it is essential to use a porous conductor consisting of a material having a degree of porosity with pore diameters of 10 – 1000 μm as a cathode member to increase the conductivity of the cathode. The Examiner alleged that such cathodes having the specific pore size are better conductors and can be used in electrochemical applications involving alkali-metal technology. The Examiner further alleged that since the prior art directly teaches a pore diameter of at least 10 – 15 μm, a prima-facie case of

obviousness still exists. Moreover, the Examiner alleged that JP '431 and the present application share the same field of endeavor as they both address and disclose alkali metal-sulfur based batteries and their related technologies. For the following reasons, and for the reasons provided in Applicants' reply of January 23, 2006, incorporated herein by reference, this rejection is respectfully traversed and reconsideration is requested.

In the first place, it should be noted that the combination of Chu and JP '431 does not teach or suggest all of the express limitations of independent claim 1. In particular, claim 1 of the present application reads in part "...a positive electrode having an electron-conductive path and an ion-conductive path and comprising: a positive active material including an active sulfur, and pores of an average size greater than or equal to substantially 5 μm and less than and including 15 μm having both electron-conductive and ion-conductive properties, where the active sulfur is disposed in the pores during an electrochemical reaction of the lithium-sulfur battery..." [emphasis added]. On the other hand, JP '431, which the Examiner relies upon for allegedly teaching the claimed pore sizes, describes a porous conductor consisting of a graphite felt or cloth having pore diameters ranging from 10 mu to 1000 mu. JP '431 contains absolutely no teaching or suggestion as to what the average pore size is of the graphite felt or cloth. Clearly, an average pore size can not be assumed from a disclosure of a range of pore sizes in a material and JP '431 contains no teaching or suggestion that an average pore size of its material would lie within the claimed range. The allegation made by the Examiner that in JP '431, one of the two end points, 10 μm, constitutes a valid data point and fully encompasses the claim as a specific disclosure of a discrete embodiment of the invention, is therefore without basis, since JP '431 does not disclose any material having an average pore size of 10 μm. Thus, JP '431 does not overcome the failure of Chu to teach the average pore size of independent claim 1, and the combination of Chu and JP '431 therefore does not teach or suggest all of the features of independent claim 1.

Moreover, even if JP '431 were considered to describe average pore sizes, and, as discussed above, it is Applicants' position that it does not, JP '431 clearly teaches away from the lower range of pores for its conductor. In particular, referring to the full Japanese document, JP '431 describes that a graphite material having a pore size of 240 μm in Example 1, 350 μm in Example 2, 170 μm in Example 3, 200 μm in Example 5, and 150 μm in Example 6 improves the battery performances, but that a graphite material having a pore size 8 μm, as in Example 7, deteriorates the battery performances. Therefore, a person skilled in the art would not be motivated by JP '431 to consider a positive active material with an average pore size greater

than or equal to substantially 5 μm and less than and including 15 μm according to the present claims.

Moreover, as noted in Applicants' reply of January 23, 2006, there is no motivation to combine the teachings of Chu and JP '431. In particular, the positive electrode of Chu is made from an electrode composition comprising active-sulfur, an electronically conductive material and an ionically conductive material intermixed with the active sulfur (see, for example, Col. 5, lines 1 – 8 of Chu). Chu not only does not mention specific pore sizes of its material, but also does not describe or recognize porosity at all in its material. Moreover, there is no motivation for incorporating pores into the material of Chu in order to increase conductivity of sulfur. Chu already suggests a mechanism for improving conductivity, which is to thoroughly and uniformly disperse an active-sulfur in an electronically conductive material and an ionically conductive material. There is nothing in JP '431 that teaches or suggests that the addition of pores to such a uniform dispersal of Chu would have any effect on its conductivity. Therefore, the Examiner's alleged motivation to combine Chu and JP '431 in order to achieve an increase in conductivity is without basis.

Moreover, Chu teaches away from the modification proposed by the Examiner. As noted previously, Chu, throughout its specification, repeatedly emphasizes that its positive electrode material should be homogeneous and that segregation, agglomeration or heterogeneity should be avoided. JP '431, on the other hand, explicitly states that in order to increase the conductivity of sulfur, it is essential to use a porous conductor consisting of graphite felt or cloth (which, by its nature, cannot be mixed with a sulfur material to form a homogeneous composition). JP '431 does not teach or suggest any other ways of providing porosity other than providing a graphite felt or cloth. However, combining the graphite felt or cloth of JP '431 with the electrode composition of Chu goes against the explicit teaching of Chu that the positive electrode material should be a material that is homogeneously mixed. Accordingly, a person skilled in the art would not be motivated to combine Chu and JP '431 for this additional reason.

Separate argument for patentability of claims 10 - 16

As a separate argument for the patentability of claims 10 – 16, these claims relate to a lithium-sulfur battery wherein the positive electrode is prepared by coating a composition including a conductive agent, a binder, and a plasticizer onto a current collector, removing the plasticizer from the composition coated on the current collector with an organic solvent to generate pores in the composition coated on the current collector; and injecting the polysulfide solution into the generated pores. It is respectfully submitted that the product that is obtained by

these steps is clearly different and distinguishable from any product that would be made by combining Chu and JP '431. In particular, even if Chu and JP '431 could be combined, the result at best would be a combination of an active sulfur material and a graphite felt or cloth. Clearly, a product made by a process of coating a conductive agent, binder and plasticizer onto a current collector, removing the plasticizer to generate pores and filling the pores with a polysulfide solution, as required by claim 10, would be different, chemically and morphologically, from a material made by combining an active sulfur material with a graphite felt or cloth.

Moreover, the Examiner is clearly in error in continuing to allege that the porosity of the positive electrode as claimed includes zero porosity or a pore-free material and that no removal of plasticizer is required. Claim 10 depends ultimately from claim 1, which clearly requires a non-zero average pore size. Thus, the allegation made by the Examiner that no removal of plasticizer is required in the claim is clearly without basis. Therefore, claims 10 – 16 are allowable over Chu and JP '431 for this additional reason.

Therefore, the rejection of claims 1 - 4, 8-17, 38, and 39 over Chu and JP '431 should be withdrawn.

Rejection of claims 5-7 in view of Chu, JP '431, and Kovalev et al.

At pages 8 – 9 of the Office Action, the Examiner rejected claims 5-7 under 35 U.S.C. §103 as allegedly obvious in view of Chu, JP '431, and Kovalev et al. (U.S. Patent No. 6,652,440) ("hereinafter referred to as "Kovalev"). The Examiner applied Chu and JP '431 as discussed above. The Examiner acknowledged that Chu and JP '431 do not expressly disclose the specific particle size of the elemental sulfur. The Examiner alleged that Kovalev teaches electroactive cathode materials for electrochemical cells wherein the cathode materials comprise sulfur-sulfur bonds such as elemental sulfur and that the cathode materials are useful in batteries employing alkali-metal anodes, in particular, lithium or lithium alloy anodes and that in one embodiment, the particle size of the elemental sulfur is from 0.01 to 100 microns. The Examiner took the position that it would have been obvious to one skilled in the art at the time the invention was made to use the specific particle size of the elemental sulfur of Kovalev in the lithium-sulfur battery of Chu and JP '431 on the alleged grounds that Kovalev teaches that elemental sulfur having the claimed particle size is useful for making positive electrodes of lithium-sulfur batteries because this particular positive electrode material exhibits satisfactory specific capacity in combination with a lithium anode. For the following reasons and for the reasons provided in Applicants' response of January 23, 2006, incorporated herein by reference, this rejection is respectfully traversed and reconsideration is requested.

In the first place, it should be noted that the combination of Chu, JP '431 and Kovalev does not teach or suggest all of the express limitations of claims 5 - 7. In particular, claim 5 reads as follows: "The lithium-sulfur battery according to claim 4, wherein an average particle size of the elemental sulfur is greater than 0 μm and is up to 20 μm." Claim 6 reads as follows: "The lithium-sulfur battery according to claim 4, wherein an average particle size of the elemental sulfur is greater than 0 μm and is up to 10 μm." Claim 7 reads as follows: "The lithium-sulfur battery according to claim 4, wherein an average particle size of the elemental sulfur is greater than 0 μm and is up to 5 μm" [emphasis added]. On the other hand, Kovalev, which the Examiner relies upon for allegedly teaching the claimed particle sizes of elemental sulfur, describes a graft polymer formed by dispersing elemental sulfur having a particle size from 0.01 microns to 100 microns and then adding a polymer precursor and polymerization initiator. Kovalev does not teach or suggest what the average particle size is its elemental sulfur. Clearly, an average particle size can not be assumed from a disclosure of a range of particle sizes in a material, and Kovalev contains nothing that would teach or suggest an average particle size within the ranges specified in claims 5, 6 and 7. Thus, Kovalev does not overcome the failure of Chu and JP '431 to teach the average particle sizes of claims 5, 6 and 7, and the combination of Chu, JP '431 and Kovalev therefore does not teach or suggest all of the features of these claims.

Moreover, Kovalev et al. does not otherwise cure the above-noted defects of the combination of Chu et al. and JP '431 as applied to independent claim 1, from which claims 5 – 7 ultimately depend. In particular, Kovalev contains no description relevant to the requirement of independent claim 1 regarding the average pore size of a positive active material of a positive electrode. The combination of Kovalev, Chu and JP '431 therefore does not teach or suggest all of the features of independent claim 1.

Moreover, contrary to what is alleged by the Examiner, there is no motivation to combine the elements described in Kovalev with elements described in Chu and JP '431. Kovalev relates to an electroactive graft organic polymer that can be used as cathode material in an electrochemical cell, and the disclosed sulfur particle size is with respect to a method of forming such a graft polymer. There is no disclosure of elemental sulfur of the described particle sizes being used other than in the context of a graft organic polymer. Although Kovalev describes that its material has a high energy capacity and other advantages, there is nothing in Kovalev that specifically relates these advantages to the particle size of the elemental sulfur. Kovalev contains no disclosure that would lead a person skilled in the art to use elemental sulfur having the described particle sizes in the homogeneous active-sulfur/electronically conductive

material/ionically conductive material of Chu or in the melted sulfur/graphite cloth material of JP '431.

Therefore, the rejection of claims 5 – 7 over Chu, JP '431, and Kovalev et al. should be withdrawn.

CONCLUSION:

In accordance with the foregoing, it is respectfully submitted that all outstanding objections and rejections have been overcome and/or rendered moot. And further, that all pending claims patentably distinguish over the prior art. Thus, there being no further outstanding objections or rejections, the application is submitted as being in condition for allowance which action is earnestly solicited.

If the Examiner has any remaining issues to be addressed, it is believed that prosecution can be expedited and possibly concluded by the Examiner contacting the undersigned attorney for a telephone interview to discuss any such remaining issues.

If there are any additional fees associated with the filing of this Amendment, please charge the same to our Deposit Account No. 503333.

Respectfully submitted,

STEIN, MCEWEN & BUI LLP

By: Ralph T. Webb
Ralph T. Webb
Registration No. 33,047

1400 Eye Street, NW
Suite 300
Washington, D.C. 20005
Telephone: (202) 216-9505
Facsimile: (202) 216-9510

Date: May 5, 2006